The Prehistoric Fishers and Gatherers of the Northern and Western Coasts of the Arabian Sea

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Abstract This chapter is a review of the prehistory of the fisher-gatherers who settled along the coasts of the Arabian Sea and the Gulf of Oman. Previous research and studies have been centred mainly on the western coasts of the Indian Ocean. They have presented and discussed the general patterns and chronological frame of the coastal human adaptation since the early Holocene, and the recurrent presence of shell middens located close to mangrove environments. More recent research has been focussed on the northern shores of the Arabian Sea. From this region we have new evidence of the presence of fisher-gatherers communities that seasonally settled along the ancient coastline and islands of south-western Sindh and Las Bela (Balochistan) since the end of the eighth millennium BP indicating that early navigation already took place in that period. According to the archaeological evidence, the subsistence activities of these human groups were varied though seasonally based mainly on fishing and shellfish gathering. Broadly speaking marine and mangrove resources were widespread exploited along the two coasts of the Arabian Sea during favourable, well-defined periods of coastal adaptation following the varied environmental conditions and sea-level changes that took place since the beginning of the Holocene.

Keywords Early-Middle Holocene · Arabian Sea · Shell middens · Fisher-gatherers · Navigation

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1 Introduction

The study of when, how, and why coastlines were settled in the past, the human adaptations to marine and mangrove environments and the exploitation of their natural resources, and early navigation are among some of the more interesting and important issues in world prehistory (Bailey and Parkington 1988; Plaziat 1995; Erlandson, Rick 2008). The scope of this paper is to review the archaeology of the prehistoric fishing-gathering communities that settled along the coasts of the Arabian Sea and the Gulf of Oman roughly from the beginning of the Holocene to the Bronze Age, and analyse their cultural complexes (Fig. 1). At present we know little about the variability of the coastal settling of the early human groups and the way they adapted themselves to the seashore changing landscapes and environments of the Holocene (Terrell 2002: 12). Marine and mangrove resources undoubtedly played an important role in their diet, as is shown by the impressive amounts of discarded shells and fishbones (Fig. 2) accumulated in the shell middens (see f.i. Thomas and Mannino 1998; Andersen 2007; Álvarez et al. 2011), though we know that, at least from the seventh millennium BP onward herding and also hunting played an important role in their diet (Uerpmann and Uerpmann 1996, 2003; Biagi and Nisbet 2006).

However, despite the improving quality of the research currently underway, we still known too little of settlement seasonality, mobility patterns, and subsistence strategy variability of most of the coastal groups, though the research at *Umm al-Quwain* in the United Arab Emirates suggests that fishing was mainly a winter

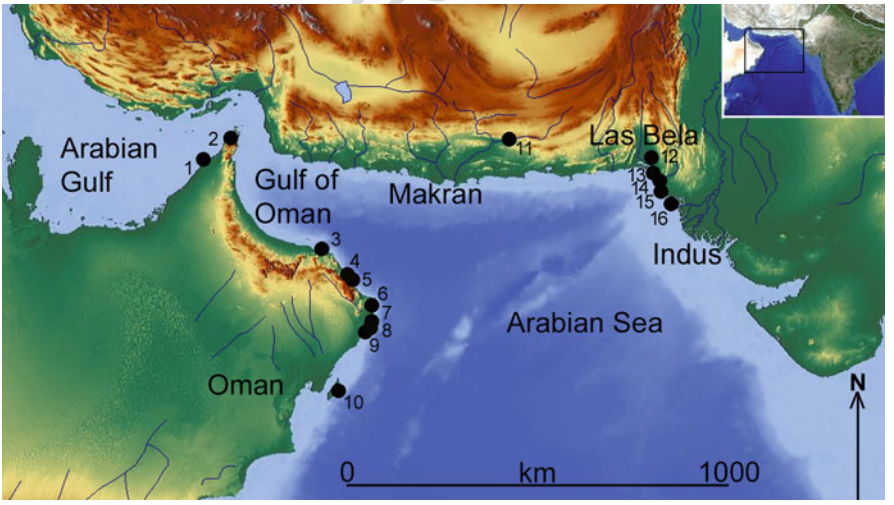

Fig. 1 Distribution map of the sites mentioned in the text: Umm al-Quwain (1), Ra's Shakhs (2), RH-5 and Ra's al-Hamrā sites (3), Bimmah (4), Wadi Shab, GAS-1 (5), Ra's al-Junayz (6), Ra's al-Khabbah (7), Ra's ar-Ruways (8), Suwayh (9), Masirah Island (10), Shahi Tump (11), Lake Siranda (12), Daun Bay (13), Ras Gadani (14), Sonari (15), Tharro Hills (16) (drawing by P. Biagi)

Fig. 2 Characteristic surface aspect of the Omani shell midden of Bimmah covered with fishbones (photograph by E. Starnini 2002)

practise within the complex subsistence economy of the coastal populations throughout a Neolithic period of ca 1500 years (Mashkour et al. 2016).

According to the archaeological evidence, fishing has always been considered a hazard as remarked by some authors. Therefore, aware of the arduous and dangerous nature of offshore fishing, it has often been considered "a low-priority mode of subsistence when alternative forms were available" (Galili et al. 2004: 97). The same authors analysing the scarce evidence of the emergence and importance of fishing in the Levant during the early Holocene reached the conclusion that "One of the explanations offered is that [. . .] fishing was a low preference mode of production, to which Neolithic communities turned only once the quantity and/or quality of terrestrial resources were reduced or impaired" (Galili et al. 2004: 93). Therefore, it seems that only in a period of crisis or in peculiar constraining environments such as desertic, arid, and hyperarid coastal lands, fishing offers an alternative and/or supplementary protein source to terrestrial resources.

In his seminal work, JM Acheson (1981) reviewing maritime anthropology explained that this field is usually subdivided in three main areas of investigation, respectively, focussing on modern fisheries, shipboard life, and prehistoric marine adaptations, each one scarcely considering the others, despite the fact that they can illuminate particular issues of mutual importance. First of all, the author observed that fishing poses similar problems all over the world (Acheson 1981: 275) and that the main contributes to the topic deal in particular with the way that human communities adapted to survive exploiting marine environment, a dangerous and alien realm in which man is poorly equipped to survive (Acheson 1981: 276).

Moreover, the same author points out that we should never forget that man always enters seawaters only with the support of artificial devices, among which are boats and vessels, and when both weather and sea conditions allow. Another important observation is that fishing gears never appear in hunting devices used out of the water and that the yield of this activity is unpredictable.

2 Environmental Conditions, Natural Resources, and Coastal Constraints

Groups of Middle Holocene fisher-gatherers settled, though with different modalities and selecting different locations, on either sides of the Arabian Sea and the Arabo-Persian Gulf since the second half of the eighth millennium BP up to the Bronze Age (Vita-Finzi and Copeland 1980; Potts 1990: 57–58; Amirkhanov 2006; Biagi 2006; Carter 2006; Boivin and Fuller 2009; Boivin et al. 2010) (Fig. 1). They were faced with common problems due to the severe environmental and climatic conditions of the inland, and the more accessible resources of the shores, with their mudflats, salt marshes, and wadi estuaries. Littoral environments were widely exploited almost everywhere geohydro-chemical conditions allowed the growth of coastal forests. This is shown by the occurrence of prehistoric shell middens with typical mangrove floral and faunal remains along over 2000 km of the eastern coast of the Arabian Peninsula and at least 400 km between the shores of Las Bela in Balochistan and the Indus Delta in Sindh (Beech 2004; Tengberg 2005; Biagi et al. 2017, 2018a).

To discover the sites and reconstruct the way, prehistoric groups adapted to the close and spatially limited environments reported above during a time span of several millennia, different methods are used. They vary from systematic surface surveys, to sophisticated interdisciplinary approaches to investigate their material culture and bioarchaeological remains. Their scope is to achieve firm data on human adaptation to environmental and climatic changes, subsistence strategies, and the exploitation of natural resources trough time.

There are striking differences between the shell middens of the eastern coasts of the Arabian Peninsula and those of Lower Sindh and Las Bela in Balochistan (Biagi 2011). Some of the Arabian middens consist of multistratified sites. They yielded evidence of circular or C-shaped habitation structures (Cleuziou 2005; Cavulli and Scaruffi 2011), rubbish pits and different types of fireplaces (Biagi and Nisbet 2006). Complex graveyards with ordinary and secondary depositions have also been excavated (Santini 1987; Salvatori 2007; Munoz 2008). The material culture remains consist of different types of fishing implements, among which are hooks (Charpentier and Méry 1997; Charpentier 2002) (Fig. 3), net sinkers, querns, anvils, hammerstones (Clarke 2009), and chipped stone tools with a variety of typological characteristics according to the activities carried out at the sites. Some of the Omani middens are huge. They were resettled and seasonally inhabited throughout a time span of ca 1000 years as is shown by radiocarbon dating and the thickness of their

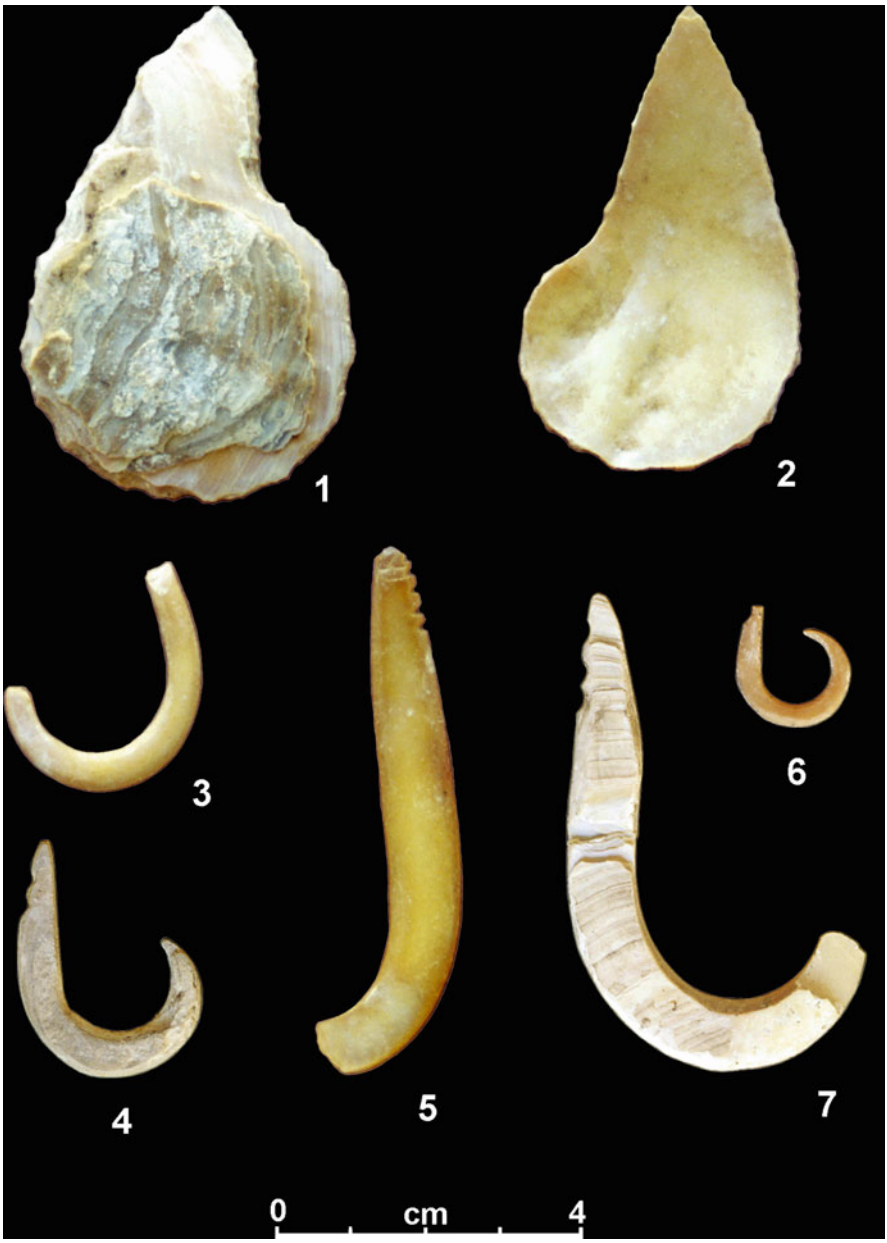

Fig. 3 Fishing gear from Omani shell middens: fish-hooks pre-forms and finished items made from *Pinctada margaritifera* marine bivalve and bone (1–3 and 5 from Ra's al-Khabbah) (photographs by E. Starnini 2002)

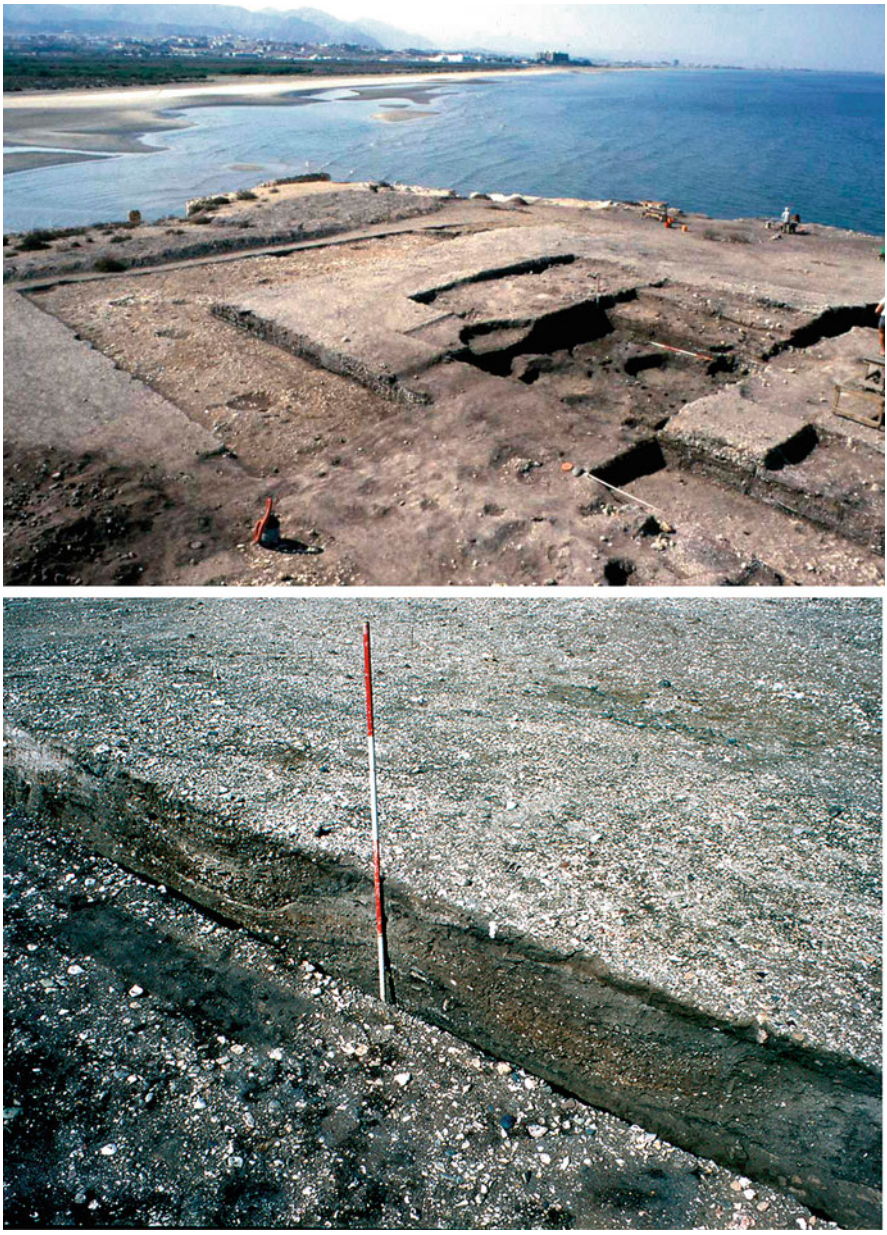

Fig. 4 The shell midden of RH-5 on Ra's al-Hamrā headland (Sultanate of Oman) with overimposed archaeological structures (top) and thick stratigraphic sequence (bottom) (photographs by P. Biagi 1986)

Fig. 5 Concentration of anvil stones in the shell midden of Daun-1 (Las Bela, Balochistan) (photograph by P. Biagi 2004)

sequences (Fig. 4). They consist of overimposed layers of marine and *Terebralia palustris* mangrove shells, fish, turtle and domesticated bones, ash, charcoal, and blow sand, which in a few cases have been accurately radiocarbon-dated (Uerpmann 1991; Biagi 1994, 1999; Zazzo et al. 2012, 2016).

The shell middens of Las Bela in Balochistan are very different. They consist of shell heaps of different size, thickness, and shape composed of fragments of *Terebralia palustris* and *Telescopium telescopium* mangrove gastropods (Soemodihardio and Kastoro 1977; Haque and Choudhury 2015). Other species are also present, mainly bivalves among which is *Anadara rhombea*, while fish, turtle, and other bones are absent as are charcoals. So far none of them yielded evidence of graves or cemeteries. The sites of the Bay of Daun (Las Bela) have yielded evidence of many stone anvils grouped together with cup marks on both faces (Fig. 5) and a few atypical hammerstones (Biagi et al. 2012: Fig. 7). Other types of stone implements are rare, though a few net sinkers have been recorded. Together with a few large-sized fishes otoliths (Girod pers. comm 2018), they show that fishing was practised at some sites at least on a small scale. The chipped stone assemblages are represented by very few artefacts often made from dark red Gadani chert whose outcrops are located ca 25 km from the sites (Biagi et al. 2013). The tools consist of bladelet artefacts among which are different types of geometric microliths.

Most of the middens of Daun and Lake Siranda (Las Bela) seem to be short time occupations; they are generally smaller but more dense and frequent. This is the case for the palaeo-mangrove of Siranda, with over 75 sites scattered along the coasts of the slowly reducing basin. This impression is reinforced by the absence of any type of man-made structure. The shell middens are most probably seasonal stations located close to mangrove forests in order to exploit the great variety of their products. The only exception is the impressive shell mound of SNR-29 along the south-eastern shore of Lake Siranda, which might have acted as a central place, surrounded by many other middens with different dimension and characteristics (Fig. 6). Most of the Las Bela sites have been radiocarbon-dated between the Neolithic and the Bronze Age by specimens of mangrove and marine shells (Biagi et al. 2012, 2017, 2018a).

The above picture seems to have abruptly changed during the Bronze Age. This is shown by the discovery of a fisher-gatherer settlement at Sonari, along the northern edge of Cape Monze (Ras Muari), close to the Hab River mouth in Sindh (Fig. 7, top). The site of Sonari yielded evidence of a few rectangular stone-walled structures systematically oriented in east-west or north-south direction, whose floor is covered with *Meretrix* marine bivalves (Fig. 7, bottom). The presence of numerous net sinkers (Fig. 8) and a great amount of marine and mangrove shells show that fishing and molluscs gathering were two of the most important activities practised at the site, which flourished during the fifth millennium BP, according to many AMS radiocarbon dates obtained from mangrove and marine shells (Biagi et al. 2018b).

At present we know that the summer monsoon affects surface and thermocline Arabian Sea circulation, causing changes not only in the periodic fish migrations but also in the local climate, currents, and tides. Based on $\delta^{18}O$ peaks measured on plankton from the continental margin of Pakistan, changes in the hydrographic properties of the Arabian Sea from 9000 to 7200 BP were correlated to changes in the South Asian Monsoon (Staubwasser et al. 2002). Eustatic changes in the sea level, based on the reconstruction of ancient shorelines, determined an ingression of the sea over many hundred kilometres in the Gulf between 12,000 BP, when "the Strait of Hormuz opened up as a narrow waterway" and the flooding of the lowlands began, and about 5500 BP "when sea levels rose above their present level by perhaps 1 or 2 m" (Lambeck 1996: 54–55). The important effects on this changing landscape, the sudden formation of a new sea invading the ancient deltas of the Tigris and Euphrates, would have played a major role in the human geography during the early Holocene (Cleuziou 2005).

Correspondingly, important climatic modifications occurred, as already recognised along the coasts of the Emirates and Oman by means of multi-proxy approaches. They show that the arid period following the Last Glacial was replaced by a phase of increasing precipitation during the early to mid-Holocene (Preston et al. 2015). This change in latitude of the Intertropical Convergence Zone (ITCZ), at present limited to the southernmost region of the Arabian Peninsula, has been reconstructed for the whole Holocene using detailed oxygen-isotope profiles obtained on stalagmites from Oman and Yemen (Neff et al. 2001; Fleitmann et al. 2007). These show a shift in the wind regimes over the Indian Ocean from the early

Fig. 6 The shell midden of SNR-29 along the south-eastern shore of Lake Siranda (top) and its surface covered by fragments of *T. telescopium* and *T. palustris* mangrove shells (Las Bela, Balochistan) (photographs by P. Biagi 2013)

Holocene southwards as a response to solar insolation causing a decrease in precipitation and shortening of the summer monsoon phases (Hilbert 2014).

Regarding the Makran coast of Iran, Quaternary beach deposits are found at 6 and more metres above the present sea level. They are not consistent with eustatic

Fig. 7 The Bronze Age fishermen site of Sonari on Cape Monze (Ras Muari) in Sindh (top) and rectangular structures with *Meretrix* marine bivalves on its floor (bottom) (photographs by P. Biagi 2014)

178 movements and can be better explained as caused by neotectonic activity (Hosseini-
179 Barzi and Talbot 2003). This is undoubtedly true also for the eastern part of the
180 northern Arabian Sea coast of Sindh from Cape Monze to Karachi (Sarwar and

Fig. 8 Net sinkers from the fishermen site of Sonari (Cape Monze, Sindh) (photographs by E. Starnini 2018)

Alizai 2013). Remote-sensing and GIS studies have pointed out the impressive rate of motion between the Arabian and Asian plate along the Makran coast that are characterised by a recent, high seismic activity. Whole sections of the coast have been interested by a strong uplift, as shown by the occurrence of raised beaches close to the seaside. The entire Makran coast is affected by recent (Quaternary and Holocene) tectonic activity that shaped the territory in multiple forms (huge mud volcanoes, strong earthquakes, coastal uplift with raised beaches, faulting occurring in younger sediments, river terraces) (Snead and Frishman 1968; Snead 2010). An uplift of ca 100 m has been suggested along the western section of the Makran coast, gradually reducing to 2–3 m in the Indus Delta (Reyss et al. 1999; Snead 2010). Sediment accretion and crustal movements are thought causing an uplift of about 1.5 mm/year also on Iranian Makran (Schlüter et al. 2002).

The impressive fan of Indus has moved southwards for hundreds kilometres in the course of Holocene, as shown by geomorphologic and radiocarbon-based archaeological data (Wilhelmy 1968; Flam 1987, 1999; Giosan et al. 2006; Biagi 2017; Biagi et al. 2018a). This movement was, and still is, partially controlled by the presence of a complex system of channels, along with one of the more extended mangroves in the world (Amjad et al. 2007).

Important local transformations took place in the morphology and habitat of many prehistoric sites because of the aforementioned changes along the shores of the whole Arabian Sea (Bailey 2004). In particular, changes in runoff, river discharge, and groundwater level (Tamburi 1973) have frequently originated mud-salted flats and sabkhas along the coastal areas, where formerly mangroves flourished. This is the case for several prehistoric sites (palaeo-lagoons) located along the coasts of Oman among which are Ra's al-Hadd, Suwayh, Ra's al-Khabbah, and Ra's Ruways (Berger et al. 2005, 2013).

In Pakistani Balochistan, a similar spectacular situation is known from Lake Siranda, a vast sabkha depression at present surrounded by dunes on its western and southern sides that cut its connection from the sea. Little is known of the early history of the lake. Most authors believe that it was formerly part of the present Sonmiani lagoon (Miāni Hor), sharing with it its dominant environmental aspects, and that it functioned as a tidal lagoon in the not-too-distant past. According to R.E. Snead, this depression was previously connected with Sonmiani from which was later separated by sand dune formations, later stabilised by vegetation (Snead 1969: 34).

The lake, ca 14 km long and 3 wide, is located in the southernmost part of Las Bela Valley. Fed mainly by summer monsoon rains, the lake is often dry. In the 1950s its maximum depth was 1.5 m in the winter and 3 m in the summer (Pithawalla 1952: 33). Along its present borders, but also in more central spots, evidence of the exploitation of mangrove molluscs (*Terebralia palustris* and *Telescopium telescopium*) by prehistoric gatherers is shown by an impressive number of shell middens. They have been radiocarbon-dated between 7200 ± 35 (GrA-54,290) and 5065 ± 40 BP (GrA-55,817), when the basin had already lost its openings with the sea (Biagi et al. 2017, 2018a) (Fig. 9), showing that also this coast of the Arabian Sea

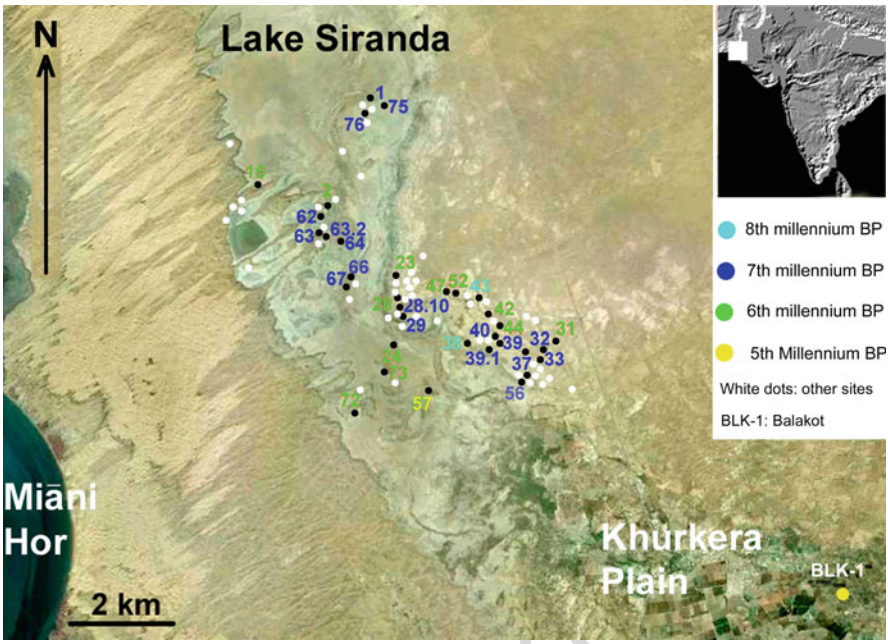

Fig. 9 Distribution map of the AMS-dated shell middens discovered along the coasts of Lake Siranda (Las Bela, Balochistan) (drawing by P. Biagi and R. Nisbet 2017)

was scarcely populated (or unpopulated?) prior to the eighth millennium BP as already observed for Arabia (Preston and Parker 2013).

The emerging picture shows that early-mid-Holocene coastal populations of fisher-gatherers accessed to a number of selected and various environments. They provided excellent resources in terms of foodstuff (fish, molluscs, birds, and terrestrial mammals), raw material (salt, timber- and firewood, fibres, dyes), and freshwater. In spite of their apparent homogeneity, mangroves shelter a number of animal and vegetal species, as well as seagrasses (Kathiresan and Rajendran 2005). The latter sometimes covering very large surfaces adjacent to mangroves, they play a role as a major source of primary productivity in areas where other producers are not abundant (Hogarth 1999).

In the course of time, both climate and tectonic movements have produced changes in the coastal environments and their biotic sources. In Sindh and Las Bela (Pakistan), apart from the aforementioned case of Siranda, part of the mangroves growing between Sonmiani and the Hab River (Gadani, Phuari, Daun, and Sonari) extinguished in prehistoric times, though some (f.i. Sonari) only in the last few centuries (Biagi et al. 2018b). Along the eastern coasts of the Arabian Peninsula, many mangroves disappeared, probably due to a deficit of freshwater input from inland (Berger et al. 2013). Some other lost part of their biodiversity: the case of *Rhizophora*, one of the typical mangrove trees, is noticeable. This tree that is still growing in the mangroves of the northern Arabian Sea coast is no longer found in

Fig. 10 The mangrove swamp of Qur'm, at Muscat (Sultanate of Oman) (top), and Miāni Hor (Las Bela, Balochistan) (photographs by P. Biagi 1986 and 2013)

today monospecific (*Avicenna marina*) Arabo-Persian Gulf mangroves (Fig. 10), but still present along the Arabian coasts of the Red Sea. However, *Rhizophora* was a consistent element along the eastern coasts of Arabia peninsula, and its wood was

exploited by the prehistoric communities up to historic times (ninth to thirteenth century AD) (Gale 1994; Tengberg 2005).

There is growing evidence along the Oman coast (Ja'alan) of a dry period around 5400 BP, following some centuries of a wet climate. The abandonment of the previous shell middens is seen as a consequence of this climatic crisis, which "would lead to the reduction of mangroves, before their death at the end of the third millennium cal BC" (Charpentier et al. 2016: 353).

A similar, more or less contemporaneous climatic stress seems to have occurred along the Indus Valley, as well as along the shores of the Arabian Sea, where a 4.2 ka BP drought is suggested to be one of the causes of the decline of both Mesopotamia and Indus Civilizations (Staubwasser et al. 2003; Farooki et al. 2013; Dixit et al. 2014; Sarkar et al. 2016; Giosan et al. 2018). However, the effect the new conditions played in reshaping economy, social organisation, and land use of the ancient hunter-gatherers is unknown.

3 History of the Research

During the second half of the 1970s, modernisation caused serious damage to much of the coastal landscape of the Arabian Sea countries. The process accelerated when the Sultanate of Oman, the U.A.E., and in general the Gulf countries developed and intensified oil and gas extraction and discovered recently a strong bias towards the tourism, dramatically increasing the road construction and urbanisation of the coasts. This process resulted in the destruction or damage of countless archaeological sites (for Oman, see Durante and Tosi 1977; Uerpmann and Uerpmann 2003). However, most of the Gulf countries developed in parallel a protection policy towards their cultural heritage, promoting rescue excavations prior to destruction (Crassard and Drechsler 2013), with the help of foreign archaeologists (Fig. 11). It should be emphasised that, during those times, the Gulf countries did not have a class of native archaeologist, and the first professionals became those who had been sent abroad to study thanks to scholarships provided by the government of the different states.

Consequently, during the last century, relatively little archaeological information was published by the Gulf countries prior to the 1980s and even less in Arabic. For instance, the first international conference on the archaeology of the United Arab Emirates was organised in Abu Dhabi only in 2001 (Potts et al. 2003).

Our knowledge of the first fishing-gathering communities of south-eastern Arabia is indeed uneven depending on focus and intensity of research. To make an example, until the beginning of the 1980s, the archaeological map of the U.A.E. was still blank with the exception of a few sites (Vogt 1994: 113). Soon after, systematic investigations began in connection with oil boom. With the help of French and German archaeologists, several coastal sites were discovered and excavated. They showed that human occupation took place from the mid-Holocene to the fifteenth to eighteenth century AD, though the prehistoric archaeology of the Lower Gulf littoral is mainly a typical "archaeology of shell middens" (Vogt 1994: 116).

Fig. 11 Rescue excavations underway at the shell midden of Ra's al-Khabbah/Qubba, Sultanate of Oman (photograph by E. Starnini 2002)

At present information is available for the sites of the south-eastern edge of the Arabo-Persian Gulf, where the lagoon of *Umm al-Quwain* has shown evidence of Neolithic shell middens with exported Ubaid pottery and domesticated animal bones. These finds contribute to the knowledge of both the history of navigation along the southern shores of the Gulf and the interpretation of the complex subsistence economy pattern of their inhabitants, which can be compared in some ways with that of RH-5 at Muscat (Uerpmann and Uerpmann 1996, 2003; Mashkour et al. 2016).

All the shell middens and shell scatters discovered along the northern coast of the Arabian Sea of Lower Sindh and Las Bela (Balochistan) (Biagi 2011, 2013; Biagi et al. 2012, 2013, 2017) were unknown until the beginning of the 2000s. This fact contrasts with a wider, though rather different amount of data available from the coast of Oman already in the same years where pioneer research started during the late 1970s (Beech 2003; Uerpmann and Uerpmann 2003; Berger et al. 2005, 2013; Cleuziou 2005; Charpentier et al. 2016).

Shell middens seem to be scarcely represented or even absent along the western coast of the Emirates, while the Dubai-Sharjah territory marks the beginning of a rather dense though intermittent distribution of middens stretching as far as the northern coast of Ras al-Khaimah (Uerpmann and Uerpmann 1996) along the western shores of the Musandam Peninsula where only one protohistoric shell midden is known at Ra's Shakhs (Biagi 2003). Late Islamic shell middens are considered to mark the end of the local shell gathering (Vogt 1994: 117) that was

Fig. 12 Aerial view of Qur'm mangrove swamp at Muscat, Sultanate of Oman (photograph by R. Salm 1990)

still a common practise in Ras al-Khaimah during the 1950s, although in those years, this activity did not play a substantial role in the daily diet of the local inhabitants.

The history of research in Oman is somewhat similar. The first sites were discovered occasionally during the second half of the 1970s, when the urbanisation of Ra's al-Hamrā headland took place at Muscat, at the southern end edge of the Batinah coast, where the Qur'm mangrove swamp opens at the mouth of Wadi Aday (Durante and Tosi 1977; Biagi and Nisbet 1993) (Fig. 12). In those years most of the shell middens of the cape were destroyed with the exception of sites RH-5, RH-6, and RH-10 that were later systematically excavated by the Italian Archaeological Mission and yielded an impressive amount of data as well as a first chronology frame of the coastal settling of the region (Figs. 13 and 14).

This situation can be compared with that of Lower Sindh, where urbanisation and industrialisation concur to the systematic destruction of all the archaeological sites of the coast and the interior, in particular where flint outcrops exploited during the Indus period for tool-making are present, as they are nowadays seemingly to decorate private residence walls in Karachi (Biagi and Nisbet 2011). Unfortunately, also some of the shell middens of Las Bela, those of Daun, for instance, are currently in danger and will soon disappear. In the case of Sindh, no action of preventive and rescue archaeology has ever been taken by any of the local and government authorities and research centres, among which are universities, despite the precise archaeological rules and regulations of the country inherited by the former British

Fig. 13 Aerial view of the cape of Ra's al-Hamrā at Muscat, Sultanate of Oman with excavations underway at the shell middens RH-5 and RH10 (top), and shell midden RH-6 during excavation (bottom) (photographs by R. Salm 1990)

333 administration. Soon this situation will lead to the complete loss of all the archae-
334 ological sites of this region of the north Arabian Sea coast that represents an
335 invaluable part of the archaeological heritage of the Islamic Republic of Pakistan.

Fig. 14 The coastal site of GAS-1 at Wadi Shab in the Sultanate of Oman, between the road and the coastline, on the terrace where the car is parked (photograph by P. Biagi 1992)

Moreover, it will cause the disappearance of any source of information regarding the history of human adaptation to coastal environment.

4 Resources Exploitation

In one of his papers, M. Beech (2004) analysed the fishbone assemblages from sites excavated along the coasts of the Arabo-Persian Gulf and the Gulf of Oman. He provided us with the first comprehensive and informative synthesis of the exploitation strategies of the marine resources in the above two regions. According to his results, there is comparatively little evidence of major changes in the selection of any particular fish species through the time (Beech 2003). This pattern is explained by the same author as probably due to the adoption of similar fishing strategies by coastal communities in different, if not by the use of the same, fishing grounds within the region.

The same author interpreted the variability pattern reported above as due to different factors, among which are the recovery methods employed during excavation, size sample, state of preservation, exploitation of different local/regional habitats, or the specialised exploitation of certain resources at particular locations in different periods of the year (Beech 2003: 302).

The scenario shows that Early Holocene hunter-fishers-gatherers selectively foraged the coastal shallow waters rich in easy-to-catch small pelagic fish (anchovies and sardines). The composition of the bone assemblages shows that sharks, in some cases up to 2 m long, were also caught. Fishing in shallow waters is reported from sites radiocarbon-dated to the tenth and ninth millennia BP, though it is rarely documented along the coasts of the Arabian Peninsula during this period (Charpentier et al. 2016).

According to the available evidence, the range of captured marine fauna is much larger from the seventh millennium BP onwards than during previous periods. Fishing affected a huge range of species, some of which are pelagic, tuna in particular. The Sultanate of Oman yielded evidence of some dwelling sites focussed on specialised fishing, in particular small- and large-sized shark, among which are those discovered at Suwayh-1 (Charpentier et al. 2016). In Arabia, sea mammals like dolphins were at times the focus of extensive fishing. Recently, selective fishing of dugong has been documented in the Arabo-Persian Gulf (Méry et al. 2009), though the general impression is that Arabian communities did not hunt cetaceans, but collected their bones from dead individuals recovered along the seashore.

5 Seafaring

The discoveries made at the Neolithic, seventh millennium BP site H3 at As-Sabiyah, at the northern end of Kuwait Bay, have shown that already in this early period navigation was undoubtedly practised at least along the southern coast of the Arabo-Persian Gulf (Lawler 2002; Carter and Crawford 2010). This impression is reinforced by the distribution of Neolithic Ubaid painted potsherds all along the same coast up to the western shore of the Musandam Peninsula (Uerpmann and Uerpmann 1996), though at present we have no evidence of its spread towards the open oceanic waters east of the Strait of Hormuz. This might indicate that Neolithic navigation was limited to the easier, shallow waters of the Gulf, which in fact acted as a closed sea also in recent times (Potts 1990).

Evidence of open sea fishing has been recorded from a settlement discovered in the Akab Islands in the Emirate of Umm al-Quwain, starting from the sixth millennium BP (Charpentier et al. 2016; Beech et al. 2017). The discovery of many tuna bones and the presence of shell fish hooks suggest that open sea fishing with boats was practiced in the islands beyond the exploitation of the shallow water resources of the local lagoon. However, fishing was undoubtedly practiced also in sheltered mangrove swamp waters, as shown by the study of the molluscs and crab remains.

Our knowledge of ancient seafaring along the northern cost of the Arabian Sea is more limited. It is shown by the discovery of marine and mangrove shells on the top of rocky outcrops in the present Indus River alluvium, formerly islands in the sea (Blanford 1880), located not far from the present coastline of Sindh and the Indus Delta. From the limestone terrace of the Tharro Hills near Gujo, we have evidence of

Fig. 15 An Omani fisher repairing a traditional *shasha* boat made from reeds at Barca, along the Batinah coast of the Sultanate of Oman (photograph by P. Biagi 1989)

Neolithic occupation radiocarbon-dated from oyster shells to the first century of the seventh millennium BP (Biagi 2011: 528).

Moreover, recent surveys carried out by the French Archaeological mission in Masirah, the largest island of the Sultanate of Oman (Charpentier et al. 2013), led to the discovery of many prehistoric settlements, the most important of which are the Neolithic site of Ra's Dah, the oldest of the entire Oman, and the Early Bronze Age sites of Jebel Sfaiq and Marsis A. The further investigations of these sites might shed light ". . .on the arrival of the famous "black boats of Magan", loaded with products from far away 4500 years ago, as well as that of other, earlier boats, made of reeds or even logs. Eight thousand years ago, Neolithic populations would have easily crossed the 20 km that separated the island from the continent. This history of the first Neolithic peoples seeking new territories has yet to be written" (Charpentier et al. 2013: 12).

More data are at present available regarding navigation between the two coasts of the Arabian Sea during the Bronze Age Indus Civilization as shown by the port structures, ship-related finds, material culture remains, fishing implements, and seals typical of this aspect in many sites of the Oman Peninsula among which is Ra's al-Junayz (Potts 1990; Méry 1996; Vosmer 1996; Ray 2003).

The typology of the boats can be suggested thanks to the discovery of bitumen slabs at Ra's al-Junayz site RJ-2 (Vosmer 1996: 227) with sub-actual ethnographic parallels, since we know that simple vessels made of canes and cords were still manufactured along the Batinah coast of Oman just a few decades ago (Fig. 15).

6 Social Aspects of the Exploitation of Marine Resources

Since decades anthropologists have been involved in the study of fishing societies (Acheson 1981), considering the ethnographic body and discussing in particular the basic issue of management of fishing territories, despite the difficulties to provide an exhaustive picture especially for extinct societies (Durrenberger and Pálsson 1987). The clue question is whether or not the access to the exploitation of the sea resources in prehistory was free or ruled and regulated and if ancient groups of fishermen operated or not a systematic distinction among concepts of ownership, territoriality, access, and control of sea territories (Nadjmabadi 1992).

We can suggest that some form of regulation of fishing was introduced only when fished resources became part of a complex system with many components, among which are increasing demand, processing, shipping, distribution, policy, and others. It probably happened around the middle of the fifth millennium BP, during the Bronze Age Mature Indus period, when we can foresee both intensification of trade and the emergence of complex urban societies interacting between and across the Gulf and the Indian Ocean (Ray 1999; Méry et al. 2012; Charpentier et al. 2013). Among demanded goods and raw materials, there where unique shell species like *Turbinella pyrum*, *Fasciolaria trapezium*, and pearl oysters who live in well-defined habitats. They were exploited for the production of specific crafts among which are inlayed objects, beads, pendants, and bangles (Ray 2003).

The existence of a complex hierarchy of interaction spheres governing the gathering and distribution of such a resource along the coasts of the Arabian Sea has been postulated for the Indus Civilization (Kenoyer 1983), though increasing evidence provided by the research carried out along the coast of Las Bela during the last decade would point to a Neolithic age for the beginning of this exploitation (Biagi et al. 2018a).

Regarding fish, there is evidence of extra-regional trade at Harappa, in Punjab, starting from the early Bronze Age Kot Diji phase to the end of the Indus Civilization (Belcher 1994, 1998: 391). It shows that intra-regional trade between coastal and interior riverine sites involved both marine fishes (jacks—carangids; marine catfish—ariids; and, mackerel—scomberids) and shells (Belcher 1991, 1998). It has been postulated that marine fishes probably were traded dried/salted from a coastal community settled over 850 km to the south and were brought in with other marine products including shellfish (Kenoyer 1983).

7 Inferring Fishing Gears and Methods from Material Culture Remains

Following an ethnoarchaeological approach, attempts have been made at the reconstruction of fishing nets employed during the Bronze Age Indus Civilization (Belcher 1999). The large quantity of fishbones recovered from the Chalcolithic to

Indus period mound of Balakot in the Kurkhera Plain of Las Bela in Balochistan, gave the opportunity to infer fishing strategies through the detailed analysis of this unique bone sample, concluding that nets were probably employed to capture most species (Belcher 1997).

Thanks to the results of the research conducted along the Makran coast, we know that already by the end of the sixth millennium BP, the relationships between the inhabitants of the interior and those of the coastline were well established in term of trade and food supply, and that they intensified during the following fifth and fourth millennia BP (Desse-Berset and Desse 2005).

These relationships are confirmed also by the discovery of the remains of an exceptionally well-preserved carbonised net made from leaves' fibres, most probably a local palm, from a context radiocarbon-dated to the first half of the fifth millennium BP by the French archaeological expedition at Shahi Tump in the Kech Valley of Balochistan, ca 120 km from the coast (Thomas et al. 2012). Due to many reasons, it is impossible to know if it was ever employed for fishing or not. The net was found in association with large oceanic shells employed for making jewellery or containers as grave goods, together with many sea fishbones from both domestic and funeral contexts. Among the latter is a more than one metre long sawfish rostrum (Desse-Berset and Desse 2005). The data reported above show that fish and fishing played an important role to the inhabitants of the Kech Valley as a source of food and also as a symbolical item.

In Oman, the leaves of desert palms are traditionally used along the Jazir coast and in Dhofar to make fishing nets of various dimensions (Richardson and Dorr 2004: 369; Thomas et al. 2012). We can suggest that fishermen used this raw material in the past as well as cotton. The utilisation of cotton nets can be inferred from ethnographic parallels. We know that lime made from shells was used in the last centuries in Makran as a mean for water-proofing this type of fishing nets (Hughes-Buller 1907: 203; Siddiqi 1956: 65).

Other characteristic archaeological indicators of fishing are the net sinkers that consist of flat pebbles with two opposed notches along the long sides, around which a string can be firmly tied. These objects are often reported in the literature as "net weights,", "notched pebbles", "fishing weights" or "notched weights".

Net weights are other common items from some of the sites of the Arabian Sea coasts (Uerpmann and Uerpmann 1996: 134), where different fishing traditions might have been practised by different fishing-folks and/or as adaptive response to particular (marine, estuarine, riverine) environments and fish species (Siddiqi 1956: 69–71). Net weights or net sinkers made from small-sized wadi or beach pebbles of flat, oval-to-spherical shape, with pecked or sawn notches or an engraved perimetral groove (Vogt 1994: 124, Fig. 9.5, nn 8–11) have been uncovered in large numbers from several middens of the coast of Ras al-Khaimah (U.A.E.), Jazirat al-Hamrā, for instance, together with stone tools used for grinding, hammerstones, and anvils.

The Oman Sea is considered as one offering the major quantity of marine resources of the planet because of a favourable upwelling, and its coastal waters show a large diversity of marine fauna, both invertebrates (crustacean, echinoderms, molluscs) and vertebrates (Desse-Berset and Desse 2005). Still today those available

in proximity of the shoreline, both seasonal and permanent, permit the natives to fish simply posing their nets perpendicular to the shore without the use of a boat.

Stone net sinkers were collected from some of the sites discovered along the northern Arabian Sea coast, among which is Sonari (Fig. 8). The Sonari specimens are generally lighter than those of the Gulf of Oman Bronze Age Umm an-Nar period (Beech 2004: 63 and Fig. 33). They can be compared with a group of medium-sized sinkers from the Middle Holocene shell midden of Ra's al-Khabbah (KHB-1) in the Sultanate of Oman (Cavulli and Scaruffi 2011: 31).

Net weights are recorded as one of the material culture component connected with fishing also in the Indus Valley (Belcher 1993, 1994: 136), although typologically they are very different from those recovered from the shell middens of both the Arabian Sea coasts.

8 Discussion

Due to geopolitical constraints, during the last century, relatively little archaeological information was published on the Gulf countries prior to the 1980s. At present, after the increasing oil exploitation and consequent urbanisation, modernisation, and industrialisation of the countries, a body of archaeological information is available to the international audience that favours the reconstruction of the most ancient history of these territories.

The intensive surveys and the excavations carried out during the last 40 years along the coasts of the Arabian Sea have radically changed our view of the archaeology of this important region of south Asia, whose prehistory was almost unknown until the 1980s at least as regards the early and Middle Holocene periods, during which we assist in a dramatic increase of the number of coastal settlements, mainly shell middens (Rose 2010: 864). This fact was most probably due mainly to climatic ameliorations and the establishment of more suitable living conditions in some well-defined zones of the coastline (Kennett and Kennett 2006; Preston and Parker 2013: Fig. 2) characterised by shallow bays and lagoons around which fisher-gatherers seasonally established their camps close to mangrove forests along both sides of the Arabian Sea (Berger et al. 2005, 2013; Biagi et al. 2017, 2018b).

Though we have very little evidence of contacts between the two coastlines, at least from the beginning of the Holocene onwards, when the morphology of the Hormuz Strait was already comparable to that of the present (Kennett and Kennett 2006: Figs. 1–2), shell middens of the late eighth millennium BP are known in very similar geographic and environmental locations both along the coast of the Sultanate of Oman and that of Las Bela in Pakistani Balochistan. However, they show different traits that are remarked, for instance, by the strong technological and typological differences, we can notice between the Holocene chipped stone assemblages of the Arabian (Uerpmann 1992) and Las Bela coastal sites (Biagi 2013).

Part of the subsistence economy of these communities relied on both mangrove and marine mollusc opportunistic gathering as well as fishing, hunting, and herding,

according to the different seasons during which the sites were settled and their environmental characteristics. Fishing was nonetheless of major importance at some Omani coast sites, as reported by the abundance and variability of fishing gears from middens and settlements of different ages, from the Neolithic to the Bronze Age, among which are different types of hooks (Charpentier 2002) and net sinkers (Uerpmann and Uerpmann 2003).

Evidence of coastal seafaring is attested also along the coast of the Arabian Peninsula at least since the eighth millennium BP from the sites recently discovered in the Masirah Island (Charpentier et al. 2013) and the very beginning of seventh millennium BP from the coast of Sindh (Biagi 2011). Whether this early seafaring is connected with fishing is difficult to say on the basis of the present data. However, fishing was undoubtedly practised by the Neolithic community living on the Masirah Island (Charpentier et al. 2013: 7), while so far, we have little evidence of this practise from the shell middens of the northern Arabia Sea coastline during the same period.

The importance of the archaeology of the mythical land of the *Ichthyophagoi* (McCrindle 1972) relies on the fact that between 7000 and 4000 BP, the transition from small sedentary communities to the earliest complex state-level societies and cities of the Ubaid and Uruk periods took place in the upper Arabo-Persian Gulf. According to D. J. Kennett and J. P. Kennett (2006), this evolution cannot be explained without assuming that environmental changes played a significant role in this phenomenon. Therefore, the reconstruction of the events and archaeology of the human groups settled along the southern shores of the Gulf is very important as is their eventual role in the seafaring network connecting south Arabia and the Indus Valley with south Mesopotamia. Despite arid environment ecological constraints that compelled the coastal populations to adopt a mixed foraging and food-producing strategy comparable to that described by B. D. Smith (2001) as low-level food production, they undoubtedly witnessed the expansion of maritime trade along the margins of the Arabo-Persian Gulf, which occurred within the aforementioned transition period.

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References

Acheson JM (1981) Anthropology of fishing. Annu Rev Anthropol 10:275–316

Álvarez M, Briz Godino I, Balbo A, Madella M (2011) Shell middens as archives of past environments, human dispersal and specialized resource management. Quat Int 239(1–2):1–7. https://doi.org/10.1016/j.quaint.2010.10.025

Amirkhanov HA (2006) The stone age of South Arabia. Nauka, Moscow. (in Russian)

Amjad AS, Kasawani I, Kamaruzaman J (2007) Degradation of Indus delta mangroves in Pakistan. Int J Geol 3(1):27–34

Andersen SH (2007) Shell middens ("*Køkkenmøddinger*") in Danish prehistory as a reflection of the marine environment. In: Milner N, Craig OE, Bailey GN (eds) Shell Middens in Atlantic Europe. Oxbow Books, Oxford, pp 31–45

Bailey G (2004) World prehistory from the margins: the role of coastlines in human evolution. J Interdiscip Stud Hist Archaeol 1(1):39–50

Bailey G, Parkington J (eds) (1988) The archaeology of prehistoric coastlines. Cambridge University Press, Cambridge

Beech M (2003) The development of fishing in the U.A.E. A zooarchaeological perspective. In: Potts D, Al Naboodah H, Hellyer P (eds) Archaeology of the United Arab Emirates. Proceedings of the first international conference on the archaeology of the U.A.E. Trident Press, pp 291–308

Beech MJ (2004) In the land of the Ichthyophagi. Modelling fish exploitation in the Arabian Gulf and Gulf of Oman from the 5th millennium BC to the Late Islamic period. BAR IntSer 1217, Abu Dhabi Islands Archaeological Survey Monograph 1. Archaeopress, Oxford

Beech MJ, Charpentier V, Méry S (2017) Evidence for deep-sea fishing and cultural identity during the Neolithic period at Akab Island, Umm al-Quwain, United Arab Emirates. In: Mashkour M, Beech MJ (eds) Archaeozoology of the near east 9. In honour of Hans-Peter Uerpmann and François poplin. Proceedings of the 9th conference of the ASWA (AA) working group. Oxbow Books, Oxford, pp 331–338

Belcher WR (1991) Fish resources in an early urban context at Harappa. In: Meadow R (ed) Harappa excavations 1986–1990: a multidisciplinary approach to third millennium urbanism. Prehistory Press, Madison, pp 107–120

Belcher WR (1993) Riverine and marine fish resource utilization of the Indus Valley tradition. J Pak Archaeol Forum 2(1–2):241–279

Belcher WR (1994) Multiple approaches to the reconstruction of fishing technology: net-making and the Indus Valley tradition. In: Kenoyer JM (ed) From Sumer to Melluha: contributions to the archaeology of West and South Asia in Memory of George F. Dales. Wisconsin archaeological reports 3. Madison, Wisconsin, pp 129–140

Belcher WR (1997) Marine and riverine resource use during the Indus Valley tradition: a preliminary comparison of fish remains from Balakot and Harappa. In: Allchin B, Allchin FR (eds) South Asian archaeology 1995. Oxford and IBH, New Delhi

Belcher WR (1998) Fish exploitation of the Baluchistan and Indus Valley traditions: an ethnoarchaeological approach to the study of fish remains. PhD Dissertation University of Wisconsin-Madison, Madison

Belcher WR (1999) The ethnoarchaeology of a Baluch Fishing Village. In: Ray HP (ed) Archaeology of seafaring: the Indian Ocean in the ancient period. Indian Council of Historical Research and Pragati Publications, Delhi, pp 22–50

Berger JF, Cleuziou S, Davtian G, Cattani M, Cavulli F, Charpentier V, Cremaschi M, Giraud J, Marquis P, Martin C, Mery S, Plaziat JC, Saliège JF (2005) Évolution paléogéographique du Ja'alan (Oman) à l'Holocène moyen: impact sur l'évolution des paléomilieux littoraux et les stratégies d'adaptation des communautés humaines. Anciennes exploitations des mers et des cours d'eau en Asie du Sud-Ouest. Approches environnementales. Paléorient 31(1):46–63. https://doi.org/10.3406/paleo.2005.4783

Berger JF, Charpentier V, Crassard R, Martin C, Davtian G, López-Sáez JA (2013) The dynamics of mangrove ecosystems, changes in sea level and the strategies of Neolithic settlements along the coast of Oman (6000-3000 cal. BC). J Archaeol Sci 40:3087–3104. https://doi.org/10.1016/j.jas.2013.03.004

Biagi P (1994) A radiocarbon chronology for the aceramic shell-middens of coastal Oman. Arab Archaeol Epigr 5:17–31. https://doi.org/10.1111/j.1600-0471.1994.tb00053.x

Biagi P (1999) Excavations at the shell-midden of RH-6 1986–1988 (Muscat, Sultanate of Oman). Al-Rāfidān 20:57–84

Biagi P (2003) New rock art sites in the Musandam Peninsula. Bull Soc Arab Stud 8:24–25

Biagi P (2006) The shell-middens of the Arabian Sea and Persian Gulf: maritime connections in the seventh millennium BP? In: Al-Ansary AR, Al-Muaikel KI, Alsharek AM (eds) The city in the Arab world in light of archaeological Discoveryes: evolution and development. Abdul-Rahman Al-Sudairi Foundation, Riyadh, pp 7–16

Biagi P (2011) Changing the prehistory of Sindh and Las Bela coast: twenty-five years of Italian contribution. World Archaeol 43(4):523–537. https://doi.org/10.1080/00438243.2011.624695

Biagi P (2013) The shell middens of las Bela coast and the Indus Delta (Arabian Sea, Pakistan). Arab Archaeol Epigr 24:9–14. https://doi.org/10.1111/aae.12013

Biagi P (2017) Uneasy riders: with Alexander and Nearchus from Pattala to Rhambakia. In: Antonetti C, Biagi P (eds) With Alexander in India and Central Asia. Moving East and back to West. Oxbow Books, Oxford, pp 255–278

Biagi P, Nisbet R (1993) Environmental history and plant exploitation at the aceramic sites of RH5 and RH6 near the mangrove swamp of Qurm (Muscat-Oman). Bull Soc Bot France 139 (2–4):571–578. https://doi.org/10.1080/01811789.1992.10827129

Biagi P, Nisbet R (2006) The prehistoric fisher-gatherers of the western coast of the Arabian Sea: a case of seasonal sedentarization? World Archaeol 38(2):220–238. https://doi.org/10.1080/00438240600708188

Biagi P, Nisbet R (2011) The Palaeolithic sites at Ongar in Sindh, Pakistan: a precious archaeological resource in danger. Antiquity 85(329). http://www.antiquity.ac.uk/projgall/biagi329/

Biagi P, Fantuzzi T, Franco C (2012) The shell middens of the Bay of Daun: environmental changes and human impact along the coast of Las Bela (Balochistan, Pakistan) between the 8th and the 5th Millennium BP. Eurasian Prehist 9(1–2):29–49

Biagi P, Nisbet R, Girod A (2013) The archaeological sites of Gadani and Phuari headlands (Las Bela, Balochistan, Pakistan). J Indian Ocean Archaeol 9:75–86

Biagi P, Nisbet R, Fantuzzi T (2017) Exploiting mangroves and rushing back home fifteen years of research along the Northern Coast of the Arabian Sea, Pakistan. In: Sperti L (ed) Giornata dell'archeologia: scavi e ricerche del Dipartimento di Studi Umanistici Ca' Foscari, Venezia, pp 3–22

Biagi P, Nisbet R, Fantuzzi T (2018a) Mangroves and men: environmental changes and human impact along the northern coast of the Arabian Sea (Pakistan) from the beginning of the Holocene to the present. Archaeologische Mitteilungen aus Iran und Turan (in press) AU3

Biagi P, Nisbet R, Spataro M, Starnini E (2018b) Sonari: a Bronze Age fisher-gatherers settlement at the Hab River mouth (Sindh, Pakistan), in its environmental setting. Antiquaries J (Submitted)

Blanford WT (1880) The geology of Western Sind. Mem Geol Surv India 17:1–210

Boivin N, Fuller D (2009) Shell middens, ships and seeds: exploring coastal subsistence, maritime trade and the dispersal of domesticates in and around the ancient Arabian Peninsula. J World Prehist 22(2):113–180. https://doi.org/10.1007/s10963-009-9018-2

Boivin N, Blench R, Fuller DQ (2010) Archaeological, linguistic and historical sources on ancient seafaring: a multidisciplinary approach to the study of early maritime contact and exchange in the Arabian Peninsula. In: Petraglia M, Rose J (eds) The evolution of human populations in Arabia. Vertebrate paleobiology and paleoanthropology. Springer, Dordrecht, pp 251–278. https://doi.org/10.1007/978-90-481-2719-1_18

Carter R (2006) Boat remains and maritime trade in the Persian Gulf during the sixth and fifth millennia BC. Antiquity 80:52–63

Carter R, Crawford H (eds) (2010) Maritime interactions in the Arabian Neolithic: the evidence from H3, As-Sabiyah, an Ubaid-Related Site in Kuwait. American School of Prehistoric Research Monograph 1

Cavulli F, Scaruffi S (2011) Fishing kit implements from KHB-1: net sinkers and lures. Proc Semin Arab Stud 41:27–34

Charpentier V (2002) Archéologie de la cote des Ichtyophages. Co quilles, Squales et Cetaces du Site IV^{e}-II^{e} Millénaires de Ra's al-Jinz. In: Cleuziou S, Tosi M, Zarins J (eds) Essays on the Late

prehistory of the Arabian Peninsula. Serie Orientale Romana XCIII. Istituto Italiano per l'Africa e l'Oriente, Roma, pp 73–99
Charpentier V, Méry S (1997) Hameçons en nacre et limes en pierre d'Océanie et de l'Océan Indien: analyse d'une tendance. J Soc Océan 2:147–156
Charpentier V, Berger JF, Crassard R, Borgi F, Davtian G, Méry S, Phillips CS (2013) Conquering new territories: when the first black boats sailed to Masirahh Island. Proc Semin Arab Stud 43:1–14
Charpentier V, Berger JF, Crassard R, Borgi F, Béarez P (2016) Les premiers chasseurs-collecteurs maritimes d'Arabie (IXe-IVe millénaires avant notre ère) Early Maritime Hunter-Gatherers in Arabia (9th – 4th Millennium before the Current Era). In: Dupont C, Marchand G (eds) Archéologie des chasseurs-cueilleurs maritimes. De la fonction des habitats à l'organisation de l'espace littoral, Archaeology of maritime hunter-gatherers. From settlement function to the organization of the coastal zone. Actes de la séance de la Société préhistorique française de Rennes, 10–11 avril 2014. Paris, Société préhistorique française. Séances de la Société préhistorique française, vol 6, pp 345–365
Clarke A (2009) Craft specialisation in the Mesolithic of Northern Britain: the evidence from the coarse stone tools. In Finlay N, McCartan S, Milner N, Wickham-Jones C, Allen MJ, Mcomish D (eds) From Bann Flakes to Bushmills: papers in honour of professor Peter Woodman. Prehistoric Society research papers, vol 1, pp 12–21
Cleuziou S (2005) Pourquoi si tard? Nous avons pris un autre chemin. L'Arabie des chasseurs-cueilleurs de l'Holocène à l'Age du Bronze. In Guilaine J (ed) Aux marges des grands foyers du Néolithique. Paris, Errance, pp 123–148
Crassard R, Drechsler P (2013) Towards new paradigms: multiple pathways for the Arabian Neolithic. Arab Archaeol Epigr 24:3–8. https://doi.org/10.1111/aae.12021/a
Desse-Berset N, Desse J (2005) Les ichthyophages du Makran (Bélouchistan, Pakistan). Paléorient 31(1):86–96
Dixit Y, Hodell DA, Petrie CA (2014) Abrupt weakening of the summer monsoon in northwest India ~4100 yr ago. Geology 42(4):339–342. https://doi.org/10.1130/G35236.1
Durante S, Tosi M (1977) The aceramic shell middens of Ra's al Hamra: a preliminary note. J Oman Stud 3(2):137–162
Durrenberger EP, Pálsson G (1987) Ownership at sea: fishing territories and access to sea resources. Am Ethnol 14(3):508–522
Erlandson JM, Rick TC (2008) Archaeology, marine ecology, and human impacts on marine environments. In: Rick TC, Erlandson JM (eds) Human impact on ancient marine ecosystems. A global perspective. University of California Press, Berkeley, pp 1–19
Farooki A, Gaur AS, Prasad V (2013) Climate, vegetation and ecology during Harappan period: excavations at Kanjetar and Kaj, mid-Saurashtra coast, Gujarat. J Archaeol Sci 40:2631–2647. https://doi.org/10.1016/j.jas.2013.02.005
Flam L (1987) Recent explorations in Sind: paleogeography, regional ecology and prehistoric settlement patterns. Sindhol Stud 5–32
Flam L (1999) The prehistoric Indus River system and the Indus civilization in Sindh. Man Environ 24(2):35–69
Fleitmann D, Burns S, Mangini A, Mundelsee M, Kramers J, Villa I, Neff U, Al-Subbary A, Beuttner A, Hippler D, Matter A (2007) Holocene ITCZ and Indian monsoon dynamics recorded in stalagmites from Oman and Yemen (Socotra). Quat Sci Rev 26:170–188. https://doi.org/10.1016/j.quascirev.2006.04.012
Gale R (1994) Charcoal from an Early Dilmun settlement at Saar, Bahrain. Arab Archaeol Epigr 5:229–235
Galili E, Gopher A, Rosen B, Kolska-Horwitz L (2004) The emergence of the Mediterranean Fishing Village in the Levant and the anomaly of Neolithic Cyprus. In: Peltemburg EJ, Wasse A (eds) Neolithic revolution: new perspectives on southwest Asia in light of recent discoveries on Cyprus. Oxbow, Oxford, pp 93–103

Giosan L, Constantinescu S, Clift PD, Tabrez AR, Danish M, Inam A (2006) Recent morphodynamics of the Indus delta shore and shelf. Cont Shelf Res 26:1668–1684. https://doi.org/10.1016/j.csr.2006.05.009

Giosan L, Clift PT, Macklin MG, Fuller DQ, Constantinescu S, Durcan JA, Stevens T, Duller GAT, Tabrez AR, Gangal K, Adhikari R, Alizai A, Filip F, VanLaningham S, Syvitski JPM (2012) Fluvial landscapes of the Harappan civilization. PNAS 109:1–7. https://doi.org/10.1073/pnas.1112743109

Giosan L, Orsi WD, Coolen M, Wuchter C, Dunlea AG, Thirumalai K, Munoz SE, Clift PD, Donnelly JP, Galy V, Fuller DQ (2018) Neoglacial climate anomalies and the Harappan metamorphosis. Clim Past Discuss 14:1669. https://doi.org/10.5194/cp-2018-37

Haque A, Choudhury A (2015) Ecology and behavior of Telescopium Telescopium (Linnaeus, 1758) (Mollusca: Gastropoda: Potamididae) from Chemaguri mudflats, Sagar Island, Sundarbans, India. Int J Eng Sci Invent 4(4):16–21

Hilbert YH (2014) Khashabian: a Late Paleolithic industry from Dhofar, Southern Oman. BAR IntSer. 2601, Oxford

Hogarth PJ (1999) The biology of mangroves. Oxford University Press, New York

Hosseini-Barzi M, Talbot CJ (2003) A tectonic pulse in the Makran accretionary prism recorded in Iranian coastal sediments. J Geol Soc Lond 160:903–910

Hughes-Buller R (1907) Makrán. Text and appendices. Baluchistán District Gazetteer Series, vol VII. Indus, Karachi (1st reprint 1996)

Kathiresan K, Rajendran N (2005) Mangrove ecosystems of the Indian Ocean region. Indian J Mar Sci 34(1):104–113

Kennett DJ, Kennett JP (2006) Early state formation in southern Mesopotamia: sea levels, shorelines, and climate change. J Island Coast Archaeol 1:67–99. https://doi.org/10.1080/15564890600586283

Kenoyer JM (1983) Shell working industries of the Indus civilization: an archaeological and ethnographic perspective. PhD dissertation. University of California at Berkeley

Lambeck K (1996) Shoreline reconstructions for the Persian Gulf since the last glacial maximum. Earth Planet Sci Lett 142:43–57

Lawler A (2002) Report of oldest boat hints at early trade routes. Science 296:1791–1792

Mashkour M, Beech MJ, Debue K, Yeomans L, Bréhard S, Gasparini D, Méry S (2016) Middle to Late Neolithic animal exploitation at UAQ2 (5500–4000 cal BC): an Ubaid-related coastal site at Umm al-Quwain Emirate, United Arab Emirates. Proc Semin Arab Stud 46:195–210

McCrindle JW (1972) The commerce and navigation of the Erythaean Sea; being a translation of the Periplus Maris Eriythraei, by an anonymous writer, and of Arrian's account of the voyage of Nearkhos, from the mouth of the Indus to the head of the Persian Gulf. Philo Press, Amsterdam

Méry S (1996) Ceramics and patterns of exchange across the Arabian Sea and the Persian Gulf in the early Bronze Age. In: Afanas'ev G, Cleuziou S, Lukacs J, Tosi M (eds) The prehistory of Asia and Oceania. Colloquium XXXII. Trade as a Subsistence Strategy. Post Pleistocene Adaptations in Arabia and Early Maritime Trade in the Indian Ocean XIII International Congress of Prehistoric and Protohostoric Sciences. ABACO, Forlì, pp 167–179

Méry S, Charpentier V, Auxiette G, Pellé É (2009) A Dugong Bone Mound: the Neolithic ritual site on Akab in Umm al-Quwain, United Arab Emirates. Antiquity 83(321):696–708. https://doi.org/10.1017/S0003598X00098926

Méry S, Besenval R, Blackman MJ, Didier A (2012) The origin of the third-millennium BC fine grey wares found in eastern Arabia. Proc Semin Arab Stud 42:195–204

Munoz O (2008) Fouille du Cimitière de RH-5 a Ra's al-Hamra (Muscat, Sultanat d'Oman) Campagne 2008. Rapport Archéo-anthropologique. Muscat (unpublished)

Nadjmabadi S (1992) 'The sea belongs to god, the land belongs to us': resource management in a multi-resource community in the Persian Gulf. In: Casimir MJ, Rao A (eds) Mobility and territoriality. Social and spatial boundaries among foragers, fishers, pastoralists and peripatetics. Berg, Oxford, pp 329–342

Neff U, Burns SJ, Mangini A, Mudelsee M, Fleitmann D, Matter A (2001) Strong coherence between solar variability and the monsoon in Oman between 9 and 6 kyr ago. Nature 411:290–293
Pithawalla M (1952) The problem of Baluchistan. Development and conservation of water resources, sols and vegetation. Ministry of Economic Affairs, Government of Pakistan, Karachi
Plaziat J-C (1995) Modern and fossil mangroves and mangals: their climatic and biogeographic variability. In: Bosence DWJ, Allison PA (eds) Marine palaeoenvironmental analysis from fossils. Geological Society Special Publication, vol 83, pp 73–96
Potts DT (1990) The Arabian gulf in antiquity. From the prehistory to the fall of the Achaemenid Empire, vol 1. Clarendon, Oxford
Potts D, Al Naboodah H, Hellyer P (eds) (2003) Archaeology of the United Arab Emirates. Proceedings of the first international conference on the archaeology of the U.A.E. Trident Press, London
Preston GW, Parker AG (2013) Understanding the evolution of the Holocene pluvial phase and its impact on Neolithic populations in south-east Arabia. Arab Archaeol Epigr 24:87–94. https://doi.org/10.1111/aae.12006
Preston GW, Thomas DSG, Goudie AS, Atkinson OAC, Leng MJ, Hodson MJ, Walkington H, Charpentier V, Mery S, Borgi F, Parker AG (2015) A multi-proxy analysis of the Holocene humid phase from the United Arab Emirates and its implications for Southeast Arabia's Neolithic populations. Quat Int 382:277–292. https://doi.org/10.1016/j.quaint.2015.01.054
Ray HP (1999) Archaeology of seafaring. The Indian Ocean in the ancient period. Pragathi Publications, Delhi
Ray HP (2003) The archaeology of seafaring in ancient South Asia. Cambridge world archaeology. Cambridge, Cambridge University Press
Reyss JL, Pirazzoli PA, Haghipour A, Hattie C, Fontugne M (1999) Quaternary 225 marine terraces and tectonic uplift rates on the south coast of Iran. Geol Soc Lond, Spec Publ 146:225–237. https://doi.org/10.1144/GSL.SP.1999.146.01.13
Richardson N, Dorr M (2004) The craft heritage of Oman. Motivate Publishing, Dubai
Rose JI (2010) New light on human prehistory in the Arabo-Persian Gulf oasis. Curr Anthropol 51 (6):849–883. https://doi.org/10.1086/657397
Salvatori S (2007) The prehistoric graveyard of Ra's al Hamrā 5, Muscat, Sultanate of Oman. J Oman Stud 14:5–202
Santini G (1987) Site RH-10 at Qurum and preliminary analysis of its cemetery: an essay in stratigraphic discontinuity. Proc Semin Arab Stud 17:179–198
Sarkar A, Deshpande Mukherjee A, Bera MK, Das B, Juyal N, Morthekai P, Deshpande RD, Shinde VS, Rao LS (2016) Oxygen isotope in archaeological bioapatites from India: implications to climate change and decline of bronze age Harappan civilization. Nat Sci Rep 6 (26555):1–9. https://doi.org/10.1038/srep26555
Sarwar G, Alizai A (2013) Riding the mobile Karachi arc, Pakistan: understanding tectonic threats. J Himal Earth Sci 46(2):9–24
Schlüter HU, Prexl A, Gaedicke C, Roeser H, Reichert C, Meyer H, von Daniels C (2002) The Makran accretionary wedge: sediment thicknesses and ages and the origin of mud volcanoes. Mar Geol 185(3–4):219–232
Siddiqi MI (1956) The Fishermen's settlements on the coast of West Pakistan. Schriften des Geographischen Instituts der Universität Kiel 16(2):1–92
Smith BD (2001) Low-level food production. J Archaeol Res 9:1–43
Snead RE (1969) Physical geography reconnaissance: West Pakistan Coastal Zone. University of New Mexico Publications in Geography 1. Department of Geography, University of New Mexico, Albuquerque
Snead RE (2010) Recent morphological changes along the coast of West Pakistan. Ann Assoc Am Geogr 57(3):550–565. https://doi.org/10.1111/j.1467-8306.1967.tb00621.x
Snead RE, Frishman SA (1968) Origin of sands on the east side of the Las Bela Valley, West Pakistan. Geol Soc Am Bull 79:1671–1676

Soemodihardio S, Kastoro W (1977) Notes on the *Terebralia palustris* (Gastropoda) from the coral islands in the Jakarta Bay area. Mar Res Indones 18:131–148

Staubwasser M, Sirocko F, Grootes PM, Erlenkeuser H (2002) South Asian monsoon climate change and radiocarbon in the Arabian Sea during early and middle Holocene. Paleoceanography 17(4):1063. https://doi.org/10.1029/2000PA000608

Staubwasser M, Sirocko F, Grootes PM, Segl M (2003) Climate change at the 4.2 ka BP termination of the Indus valley civilization and Holocene south Asian monsoon variability. Geophys Res Lett 30(8):1425. https://doi.org/10.1029/2002GL016822

Tamburi A (1973) A bibliography and literature review of groundwater geology studies in the Indus River basin. Water Management Technical Report No. 25. Water Management Research in Arid and Sub-Humid Lands of the Less Developed Countries. Colorado State University Fort Collins, Colorado

Tengberg M (2005) Les forêts de la mer. Exploitation et évolution des mangroves en Arabie orientale du Néolithique à l'époque islamique. Anciennes exploitations des mers et des cours d'eau en Asie du Sud-Ouest. Approches environnementales. Paléorient 31(1):39–45. https://doi.org/10.3406/paleo.2005.4782

Terrell JE (2002) Tropical agroforestry, coastal lagoons, and Holocene prehistory in greater near Oceania. In: Yoshida S, Matthews PJ (eds) Vegeculture in eastern Asia and Oceania, JCAS symposium series 16. Japan Centre for Area Studies, National Museum of Ethnology, Osaka, pp 195–216

Thomas K, Mannino M (1998) Mesolithic middens and molluscan ecology: a view from southern Britain. Archaeol Int 2:17–19. https://doi.org/10.5334/ai.0207

Thomas R, Tengberg M, Moulhérat C, Marcon V, Besenval R (2012) Analysis of a protohistoric net from Shahi Tump, Baluchistan (Pakistan). Archaeol Anthropol Sci 4:15–23. https://doi.org/10.1007/s12520-011-0078-8

Uerpmann H-P (1991) Radiocarbon dating of shell middens in the Sultanate of Oman. PACT 29:335–347

Uerpmann M (1992) Structuring the late stone age of southeastern Arabia. Arab Archaeol Epigr 3:65–109

Uerpmann M, Uerpmann H-P (1996) Ubaid pottery in the eastern Gulf – new evidence from Umm al-Qaiwain (U.A.E.). Arab Archaeol Epigr 7:125–139

Uerpmann H-P, Uerpmann M (2003) Stone Age sites and their natural environment. The capital area of Northern Oman Part III. Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A (Naturwissenschaften), vol 31(3). Dr. Ludwig Reichert, Wiesbaden

Vita-Finzi C, Copeland L (1980) Surface finds from Iranian Makran, Iran. J Br Inst Persian Stud 18:149–155. https://doi.org/10.2307/4299697

Vogt B (1994) In search for coastal sites in pre-Historic Makkan: mid-Holocene "shell-eaters" in the coastal desert of Ras al-Khaimah, U.A.E. In: Kenoyer JM (ed) From Sumer to Melluha: contributions to the archaeology of West and South Asia in Memory of George F. Dales. Wisconsin archaeological reports 3. Madison, Wisconsin, pp 113–128

Vosmer T (1996) Watercraft and navigation in the Indian Ocean: an evolutionary perspective. In: Afanas'ev G, Cleuziou S, Lukacs J, Tosi M (eds) The prehistory of Asia and Oceania. Colloquium XXXII. Trade as a subsistence strategy. Post Pleistocene adaptations in Arabia and early maritime trade in the Indian Ocean XIII international congress of prehistoric and protohostoric sciences. ABACO, Forlì, pp 223–242

Wilhelmy H (1968) Indus Delta and Rann of Kutch. Erdkunde 23(3):177–191

Zazzo A, Munoz O, Saliège J-F, Moreau C (2012) Variability in the marine radiocarbon reservoir effect in Muscat (Sultanate of Oman) during the 4th millennium BC: reflection of taphonomy or environment? J Archaeol Sci 39(7):2559–2567. https://doi.org/10.1016/j.jas.2012.01.043

Zazzo A, Munoz O, Badel E, Bégueir I (2016) A revised radiocarbon chronology of the aceramic shell midden of Ra's Al-Hamra 6 (Muscat, Sultanate of Oman): implication for occupational sequence, marine reservoir age, and human mobility. Radiocarbon 58(2):383–395. https://doi.org/10.1017/RDC.2016.3

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